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COMPARISON OF BEHAVIOR OF CONVENTIONAL RC STRUCTURE WITH STAINLESS STEEL ENCASED CONCRETE COLUMN STRUCTURE

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ABSTRACT

In modern period of technology to get maximum advantages of structural member under earthquake is the priority. Composite structure is one option to get the job done. Composite construction is increasing rapidly so the proper dynamic design should be needed to reduce the damage during the earthquake. In this study to fulfil the adjective of reducing the damage of the structure the composite column is used. The column is steel filled/encased concrete type composite column. And the material for steel casing is stainless steel 304 grade is used in modelling. Linear static and linear response spectrum analysis is carried out to study the response of the structure under. In this study the response of the conventional RC structure is compared with the response of the composite structure in which the stainless steel encased concrete column structure. For this analysis the FEM based ETABS software is used and the effect of this composite member is observed.

KEYWORDS: Composite structure, Composite column, Stainless steel, Response spectrum, Response of building.

I. INTRODUCTION

In this study the geometrically symmetric structure is taken under consideration. The structure are design as reinforced concrete (RC) structure and as well as the composite structure to study the response of the structure. Static and dynamic analysis is carried out. In composite structure only the columns are being taken as composite member. The composite column is steel encased concrete type of composite column. To get the batter response under earthquake excitation stainless steel is used as the casing material. Stainless steel is having higher tensile strength then other carbon or mild steel. So it gives good response in building under earthquake excitation.

In dynamic analysis linear response method is carried out. Linear response spectrum analysis gives good results of the structure. The linear spectrum analysis is carried out as per IS 1893-2002 for the conventional reinforced concrete structure and as per ASCE 7-10 for the composite structure. By doing the analysis as per IS 1893-2002 the site condition is taken as medium in zone III. And by doing analysis as per ASCE 7-10 the site class taken as D and the location of the site is consider in Alaska.

II. MODELLING AND ANALYSIS

In present work the building on a plane ground surface with G+ 14 stories is modelled in FEM based ETABS software. The size of the beam got the RCC and Composite is same which is 200mm x 450mm, 200mm x 650mm, 300mm x 450mm, 300mm x 600mm, 300mm x 900mm at every floor. The beam placement is typical on every floor of the structure. The size of the column for RCC structure is 400mm x 800mm and 300mm x 800mm. while for the composite structure the size of composite column (steel encased concrete) is 230mm x 700mm and 330mm x 700mm. The external casing of composite column is provided of stainless steel grade 304. The thickness of the stainless steel casing is 15mm taken in modelling. Above mention dimension of the composite column section is including the thickness of the stainless steel casing.

The beams are loaded with the wall load of 3.44 kN/m and the terrace beams are loaded with parapet wall load of 1.276 kN/m. The live load on slab is 2.75 kN/m2. Static analysis has been carried out for the live and dead load of the structure.

Table No 1 : Seismic parameter for linear response spectrum analysis

Parameter	IS 1893-2002	ASCE 7-10
Zone	III	Alaska (00001)
Soil class	medium	D
Importance factor	1	1
Response reduction factor (R)	5	8
System over-strength	-	3
Deflection amplification	-	4.5

The necessary mass of the building are consider in the model analysis of the structure. The total number of modes are consider in such a way that model participation factor is more than 90% and model analysis consider 12 modes has been carried out.

The linear static response spectrum function is also applied in the ETABS software. As per IS 1893-2002 and ASCE 7-10 the response spectrum function are applied using following details.

For conventional and composite structure model the typical floor plan is shown in Fig. 1. For both the structure the placement of above mention beams and columns section is same in model.

The cross section of reinforced concrete column and stainless steel encased concrete column are shown in Fig. 2 and Fig. 3 respectively.

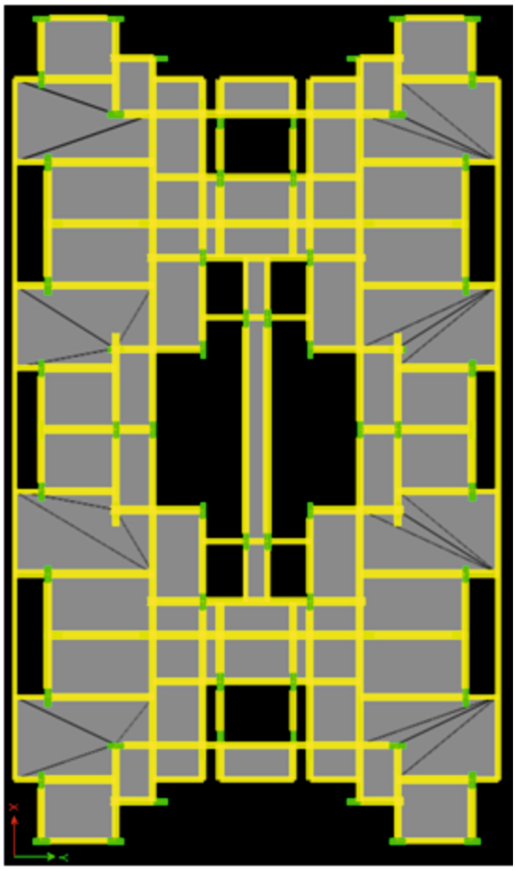

Fig. 1 - Plan of structure in RCC and composite structure

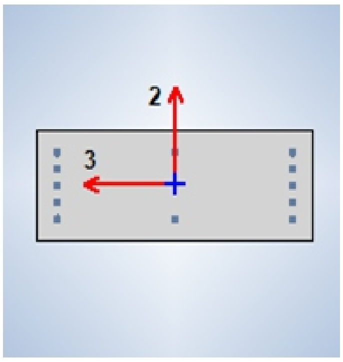

Fig. 2 - Cross section of reinforced concrete column

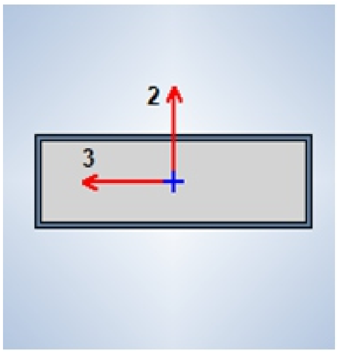

Fig. 3 - Cross section of stainless steel encased concrete column

Here in this study stainless steel grade 304 [3] [4] material is used in casing material. Tensile strength of the stainless steel grade 304 is 515 Mpa and the yield strength is 205 Mpa. These properties of the stainless steel are higher than the other mild steel sections which are being used as structural steel in composite construction. According to these properties of the stainless steel it can be used in structural steel. Stainless steel casing provide confinement effect to the column [2] [7].

According to the above mention modelling and data the static and dynamic analysis is carried out.

III. RESULTS

The linear static and linear response spectrum analysis has been carried out. Total base shear due to dead load and live load and the time period of the frist 12 modes are plotted and shown in Fig. 4 and Fig. 5 respectively. Compression of the response of the structure under bidirectional earthquake excitation is shown in graphical representation below in Fig 6 to Fig 9.

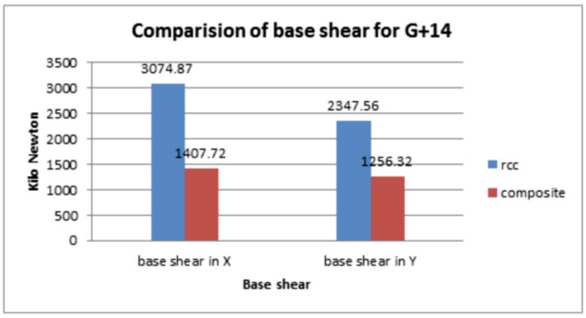

Fig. 4 – Base shear comparison

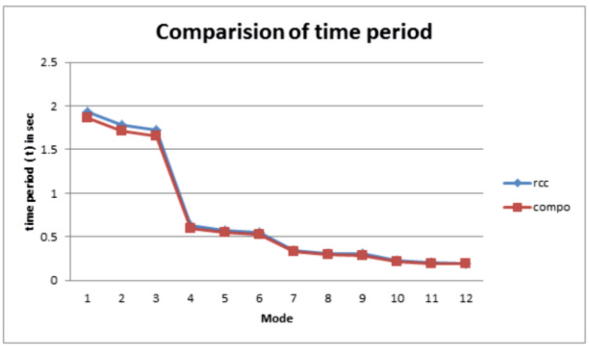

Fig. 5 – Time period comparison

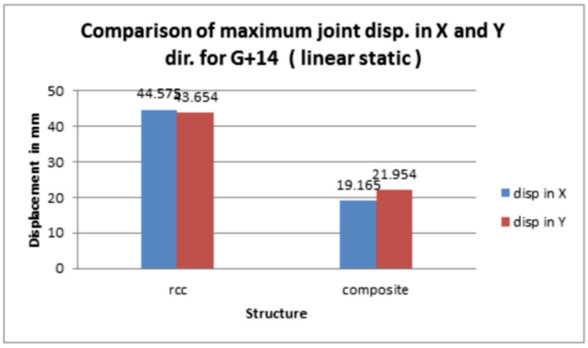

Fig. 6 – Joint displacement in linear static analysis

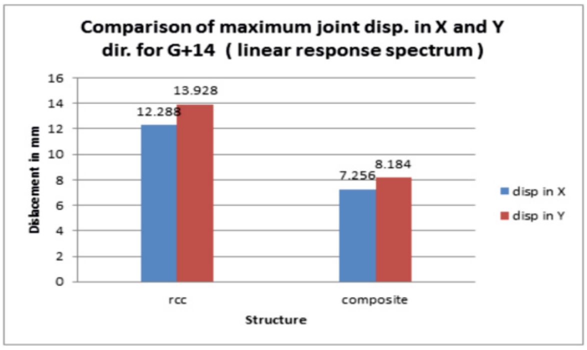

Fig. 7 - Joint displacement in linear response spectrum analysis

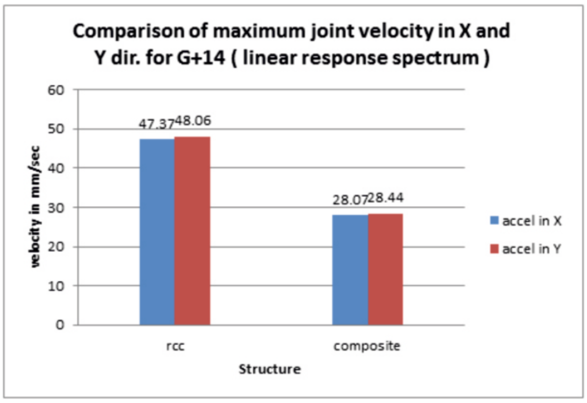

Fig. 8 – Joint velocity comparison

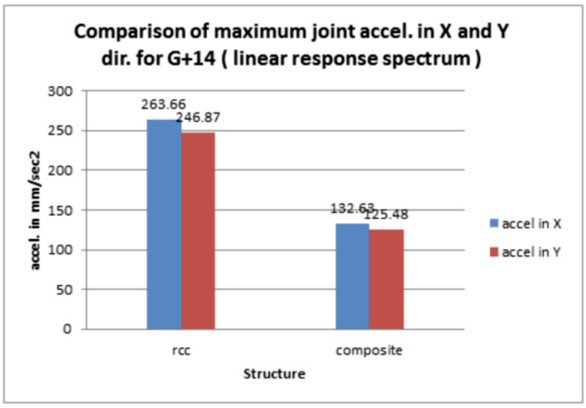

Fig. 9 – Joint Acceleration comparison

IV. CONCLUSIONS

- Comparing the base shear of both G+14 structures in linear static analysis, 54.21% and 46.48% reduction is observed in stainless steel encased concrete column structure then the conventional reinforced structure in X and Y direction respectively.

- According to the results of displacement the reduction is observed about 55.91 % and 49.70 % in x and y direction respectively in linear static analysis.

- According to the results of displacement the reduction is observed about

40.95 % and 41.23 % in x and y direction respectively in linear response spectrum analysis.

- Results of Velocity of both structure is compared, in composite structure velocity is reduced by 40.74% and 40.82% in X and Y direction then the velocity measured in reinforced structure.

- Results of acceleration of both structure is compared, in composite structure acceleration is reduced by 49.68% and 49.17% in X and Y direction then the acceleration measured in reinforced structure.

So from the analysis results we can conclude that stainless steel encased concrete column structure gives excellent performance than the conventional RC structure during seismic excitation. So the stainless steel encased column must be properly design to resist the earthquake.

V. FUTURE WORK

Further research is needed in the following aspect of the stainless steel encased concrete column structure

1. Non-linear static analysis
2. Non-linear dynamic analysis
3. Story drifts and story shear
4. Bending moments of members

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